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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM,*

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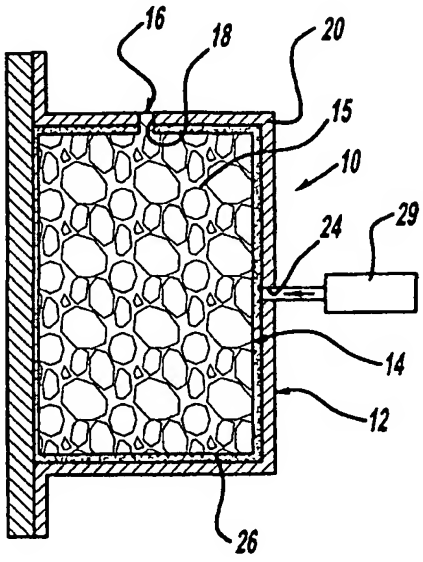
(54) Title: STRUCTURAL FOAM INSERT AND STRUCTURAL ADHESIVE



(57) Abstract: The present invention relates to a method of forming a reinforced hollow member (12). The method comprises the step of inserting a structural reinforcement insert (14) into a hollow member (12). The structural reinforcement insert (14) is then positioned in the hollow member (12) such that the structural reinforcement insert (14) and hollow member (12) define at least one fluid passageway (22). A structural adhesive (26) is applied in the fluid passageway (22) to lock the structural reinforcement insert (14) in the hollow member (12).

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STRUCTURAL FOAM INSERT AND STRUCTURAL ADHESIVE

CROSS-REFERENCE TO RELATED APPLICATION

The instant application claims priority to United States Patent Application Serial No. 10/464,306, filed 18 June 2003, the entire specification of which is expressly incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to structural reinforced parts. The structural reinforced parts are particularly useful for improving the structural integrity through section stabilization, energy management or energy absorption or dampening the sound of vehicle structural members, such as frame rails, pillar sections, rocker panels, body structures, deck lids or the like.

BACKGROUND OF THE INVENTION

Reducing automotive vehicle weight is important to meet ever more stringent fuel economy and environmental standards. In meeting these fuel economy and environmental standards, automotive designers must also seek to improve vehicle safety and quietness. Typically, to improve fuel consumption, lighter and thinner materials are being used in vehicle construction. The use of these materials reduces the durability, stiffness, energy absorption and the overall safety performance of an automobile. To increase the structural integrity of the lighter and thinner components, structural foams have been added to the interior of hollow components.

In one prior method, a foamable material is introduced into the hollow component. The foamable material is then foamed on mixing inside the component. Foaming of this type tends to fill functional holes and the foam escaping from functional holes. These functional holes are used, for example, to mount other components. One such method of this type is shown in United States Patent No. 5,678,826, A Method Of Introducing A Foam is described where a foamable material is located within the hollow member by removable plug extending through the wall of the hollow member. After the foamable material is foamed, the plug is removed.

Another attempt to increase the structural integrity of a hollow member is to provide a structural reinforcing part, such as a preformed foam part, within the hollow member. The structural reinforcing parts are typically coated prior to placing the structural reinforcing part in the hollow member with an expandable composition. The composition expands when heated to a certain temperature. Typically, the expandable composition expands to contact the inner walls of the structural member being supported. Upon expansion, the expandable composition functions to hold the structural reinforcing member in place permanently by adhering to the inner wall of the structural member. The expanded composition also helps transfer a load from the metal component from the sheet metal wall of the hollow member to the inner reinforcement to sheet metal wall of the opposite side of the hollow tube member. The use of expandable compositions provides manufacturing challenges due to the need to coat the reinforcing structural component prior to insertion into the hollow member and limits the shelf life of the components. Further, use of such expandable materials does not optimize the load transfer through the structural part because the heat expandable layer can become a weak interlayer.

SUMMARY OF THE INVENTION

The present invention relates to a method of forming a reinforced structural member. The method comprises the step of inserting a structural reinforcement insert into a hollow member. The structural reinforcement insert is then positioned in the hollow member such that the structural reinforcement insert and hollow member define at least one fluid passageway. A structural adhesive is applied in the fluid passageway to lock the structural reinforcement insert in the hollow member.

BRIEF DESCRIPTION OF THE DRAWINGS

Advantages of the present invention will be more fully appreciated from the detailed description when considered in connection with accompanying drawings of presently preferred embodiments which are given by way of illustration only and are not limiting wherein:

Figure 1 is a cross-sectional view of one embodiment of the present invention prior to the introduction of the structural adhesives;

Figure 2 is a cross-sectional view of a hollow tubular member after the structural adhesive is applied;

Figure 3 is a cross-sectional view of a second embodiment of the present invention prior to the introduction of the structural adhesives;

Figure 4 is a cross-sectional view of a hollow tubular member after the structural adhesive is applied;

Figure 5 is a cross-sectional view partially broken away showing another embodiment of the present invention;

Figure 6 is a cross-sectional view partially broken away showing another embodiment of the present invention;

Figure 7 is a cross-sectional view showing another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses.

Figure 1 shows a cross-sectional view of a structural member generally shown at 10 in accordance with one embodiment of the present invention. The structural member 10 is shown prior to final assembly and application of a structural adhesive. The structural member 10 includes a hollow member generally indicated at 12. The hollow member 12 can take any configuration. The hollow member 12 can comprise any hollow member in a vehicle, such as, for example, vehicle frame rails, pillars, rocker panels, body structures, deck lids, or the like.

The hollow member 12 is shown to comprise metal. However, it will be appreciated that the hollow member 12 can comprise any suitable material such as plastic, ceramic or the like. Additionally, the hollow member 12 is shown to comprise two segments that are fabricated, such as by welding, to

form a unitary member. It will be appreciated that any method of forming the hollow member 12 is within the scope of the present invention.

A structural reinforcing insert generally indicated at 14 is placed in the hollow member 12. The insert 14 includes a body 15. Preferably, the structural reinforcing insert 14 is made by molding a rigid closed-cell polyurethane, polyisocyanurate or hybrid foam. Additionally, the insert 14 may include any light weight, high strength cellular plastic or membrane. The structural reinforcing insert 14 includes locating pins generally indicated at 16 extending from the body 15. The locating pin 16 is adapted to be received within a mounting hole 18 in the walls 20 of the hollow member 12. The structural reinforcing insert 14 is positioned within the hollow member 12 by placing the locating pin 16 in the mounting hole 18 of the hollow member 12.

The insertion of the insert 14 into the hollow member 12 may be accomplished in any suitable manner such as by placing it by hand into the hollow member 12. The locating pin 16 is positioned in the mounting hole 18 of the hollow member 12. It will be appreciated that while only one locating pin 16 is shown on the insert 14, multiple locating pins 16 may be used. In such a case, multiple mounting holes 18 are likewise used.

In one embodiment, as shown in Figs. 1 and 2, a fluid passageway 22 is defined between the outer surface of the insert 14 and the walls 20 of hollow member 12. The fluid passageway 22 provides at least two purposes. First, the fluid passageway 22 allows any fluids that may be within the hollow member 12 to flow within the hollow member 12. Such fluids may be produced as a result of an E-coating operation. Second, the fluid passageway 22 allows for the introduction and flow and defines the placement of the structural adhesive.

The walls 20 of the hollow member 12 include one or more holes 24. The holes 24 are in fluid communication with the fluid passageways 22. The holes 24 allow fluids to flow out of the hollow member 12. Further, the holes 24 and fluid passageways 22 provide a fluid pathway to allow a structural adhesive 26 to be applied in the fluid passageway 22 to fill fluid passageway 22 and thereby lock the foam insert 14 with the hollow member 12.

More specifically, after the drainage of any fluid from the hollow member 12, the structural adhesive 26 fills the fluid passageway 22 and is used to adhere the foam insert 14 to the hollow member 12. That is, the structural adhesive 26 fills the fluid passageways 22 in such a manner that it locks the insert 14 within the hollow member to ultimately generate a composite section. Preferably, the structural adhesive 26 comprises a non-expandable structural adhesive. It is preferred that the adhesive be heat curable. Suitable structural adhesives comprise one component epoxy based adhesives. Such one component epoxy based systems are sold under the trademarks BETAMATE™ by the Dow Chemical Company and include BETAMATE™ Trade Products Nos. 73302, 73309, 73314, 73350, 73352, 1469 and 4601. It will be appreciated that two component epoxy systems may also be used within the scope of the present invention. Similarly, other suitable structural adhesives may be used within the scope of the present invention.

The structural adhesive 26 is applied as either a liquid or a paste. As best seen in Fig. 2, a suitable applicator 29, shown schematically in Fig. 2, injects or pumps the structural adhesive 26 through hole 24 and into fluid passageway 22. By utilizing a non-expandable structural adhesive in liquid or paste form, the structural adhesive 26 can be applied utilizing equipment ordinarily found at the original equipment manufacturer. The use of nonexpandable structural adhesive in connection with an insert 14 imparts

strength and stiffness to the hollow member 12 while significantly reducing the weight of the structural member 10. The adhesive seals cavities in parts and improves rigidity to the body structure contributing to enhanced NVH. Further, utilizing a non-expandable structural adhesive, allows for higher load transfer in the structural member, better reliability and less propensity for surface deformation due to mismatch of the adhesive/metal coefficient of linear thermal expansion. Additionally, there is no need to apply an adhesive to the foam insert 14 prior to placing the foam insert 14 into the hollow member.

As stated above, the insert 14 is preferably manufactured by a molding process for each specific cavity or hollow member 12. The molding process is designed to integrate the fluid passageways 22 into the insert 14. The fluid passageway 22 can take any suitable configuration in the insert 14. The insert 14 is then placed in the hollow member 12 prior a final assembly process or sheet metal manufacturing facility prior to the final processing of the hollow member 12. Once the fabrication of the hollow member 12 is complete, the non-expandable structural adhesive 26 fills the fluid passageway 22.

As shown in the embodiments of Figs. 1 and 2, the fluid passageway 22 is defined about the exterior of the insert 14 and walls 20 of the hollow member 12. It will be appreciated that the insert 14 may also contact the walls of the hollow member 12. In such a case, the insert 14 will include one or more fluid passageways 22' therethrough. Again, the fluid passageway 22' can take any suitable configuration in the insert 14. This is shown in the embodiment of Figs. 3 and 4. As with the embodiment of Figs. 1 and 2, the fluid passageways 22' of the embodiment shown in Figs. 3 and 4 allow for drainage of any material from the hollow member such as E-coat fluids and subsequently allows for the addition of the structural adhesive 26 into the fluid passageway 22' to thereby secure the insert 14 with the hollow member 12.

In this embodiment, the insert 14 fills a larger portion of the cavity in the hollow member 12. Such a structure provides for increased reliability in the application of the insert 14 in the hollow member 12. The structural adhesive 26 then is used to secure the insert 14 in place.

Fig. 5 shows another embodiment of the present invention. In Fig. 5, the insert 14 includes an outer shell 28 about the foam body 15. Preferably, the shell 28 has a configuration that clearly matches the interior of the hollow member 12. The outer shell 28 jackets the foam material. This insert 14 is then placed into the hollow member 12 to increase the strength and stiffness to help the component handle higher loads and impacts. In this embodiment, it is preferred that the outer shell 28 comprise an injection or blow molded thermal plastic shell such as, for example, Nylon. Additionally, a sheet metal shell may be used.

As shown in Fig. 5, the fluid passageway 22 is formed between the outer shell 28 and the walls 20 of the hollow member 12. The outer shell 28 also is preferably disposed about the locating pin 16 and extends through mounting hole 18. It will be appreciated that the outer shell 28 can have fluid passageways 22 of any configuration.

While the locating pin 16 is shown to be molded with the insert 14, it will be appreciated that the locating pin 16 may comprise additionally an integrated locating pin in the wall 20 of the hollow member 12 or a mechanical attachment. Such additional locating pins are shown in Figs. 6 and 7, respectively.

As shown in Fig. 6, the wall 20 of the hollow member 12 includes a locating pin 30. The pin 30 extends into the cavity defined by the hollow member 12. The insert 14 includes an opening 32 for receiving the locating

pin 30. In this embodiment, the insert 14 is located within the cavity in the hollow member 12 by placing the locating pin 30 in the opening 32. While the opening 32 is shown in outer shell 28, it will be appreciated that the opening 32 may be in the foam body 15 itself and used with or without an outer shell 28.

Fig. 7 shows an alternate locating pin. As shown in Fig. 7, the locating pin comprises a mechanical fastener, such as, for example, a screw 34. The screw 34 is received within an opening 36 in the wall 20 of the hollow member 12. Additionally, the screw 34 is received within an opening 38 in the insert 14. In this manner, the screw 34 serves to locate and hold the insert 14 in the hollow member 12. Preferably, when a screw 34 is used, the insert 14 includes an outer shell 28. The foam body 15 also may include an opening 40 for receiving the screw 34.

Only one locating pin is shown in each of the embodiments. It will be appreciated that one or more locating pins can be used to locate the insert 14 in the hollow member 12.

In order to form a structural member 10, the insert 14 is first inserted into the hollow member 12. The insert 14 may include an outer shell 28. The insert 14 is positioned in the hollow member 12 such that the insert 14 and hollow member 12 define at least one fluid passageway 22,22'. After the insert 14 is inserted into the hollow member 12, fabrication of the hollow member 12 is completed, such as by welding the components together. The hollow member 12 may then be subject to a fabrication process such as an E-coating process. The E-coating fluids drain through the fluid passageway 22 and out of the hollow member 12 through holes 24. The structural adhesive 26 is then applied in the fluid passageway 22. The adhesive is cured by the application of heat and does not expand. Once cured, the structural adhesive

26 locks the insert 14 to the hollow member 12. By utilizing non-expandable structural adhesives and a preformed insert 14, a higher stiffening reinforcement can be achieved.

The present invention has been described to preferably be used in connection with vehicles. It will be appreciated, however, that the present invention may be used in any application requiring the use of a structural member.

Presently, the preferred embodiments of the invention have been described in an illustrative manner. It is to be understood that the terminology used is intended to be in the nature of words of description. Obviously many modifications and variations are possible in light of the above teachings.

It is to be understood that, within the scope of the appended claims, the invention may be practiced other than as specifically described.

What is claimed is:

1. A method of forming a foam filled hollow member comprising:

inserting a structural reinforcement insert into the hollow member;

positioning the insert in the hollow member such that the insert and hollow member define at least one fluid passageway;

applying a structural adhesive in the fluid passageway to lock the insert in the hollow member.

2. The method of claim 1 further comprising the use of a non-expandable structural adhesive.

3. The method of claim 1 further comprising performing an E-coating process and draining the E-coating fluids through the fluid passageway.

4. The method of claim 2 further comprising heating the structural adhesive.

5. The method of claim 2 further comprising applying the structural adhesive as a liquid into the passageway.

6. The method of claim 2 further comprising applying the structural adhesive as a paste into the passageway.

7. The method of claim 2 further comprising utilizing a one component epoxy as the structural adhesive.

8. The method of claim 2 further comprising utilizing a two component epoxy as the structural adhesive.

9. The method of claim 2 further comprising utilizing a foam as the structural reinforcement insert.

10. The method of claim 9 further comprising placing a shell about the foam to form the structural reinforcement insert.

11. The method of claim 9 further comprising selecting the foam from the group comprising polyurethane, polyisocyanurate and hybrid foam.

12. The method of claim 1 further comprising positioning the insert by placing a locating pin on the insert in an opening in the hollow member.

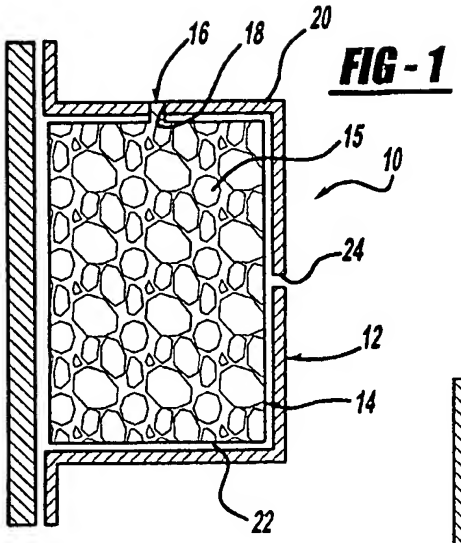

FIG - 1

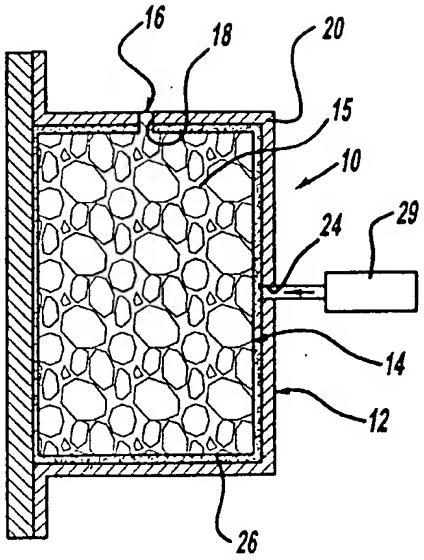

FIG - 2

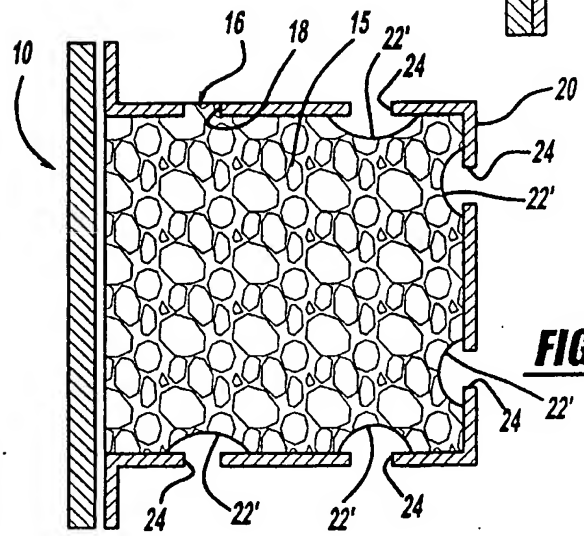

FIG - 3

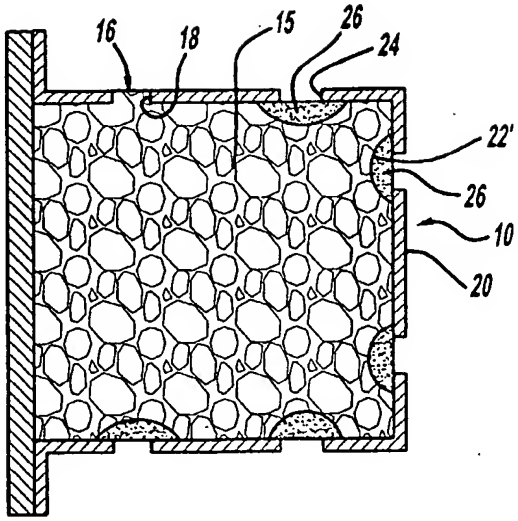

FIG - 4

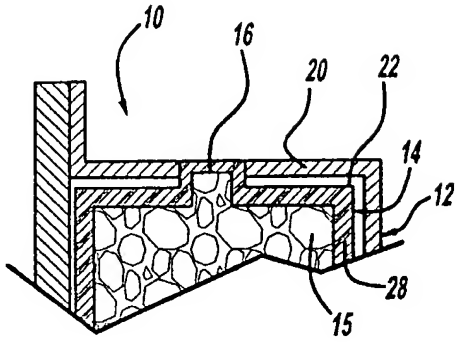

FIG - 5

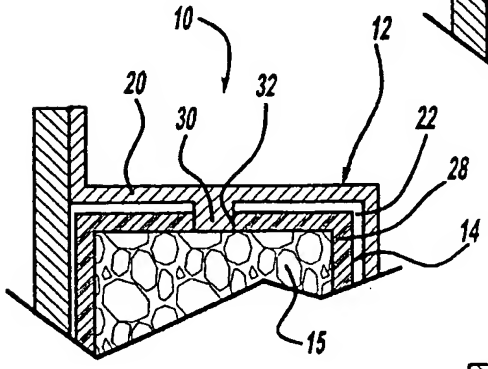

FIG - 6

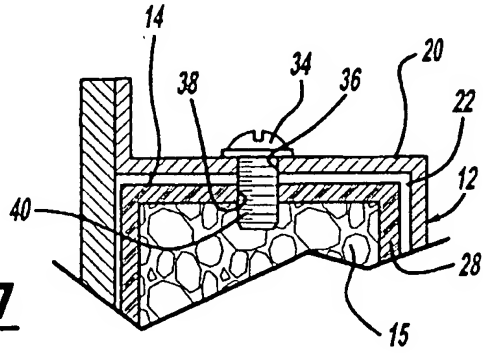

FIG - 7

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2004/019304

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B62D29/00 B29C44/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B62D B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 931 474 A (DAWES KEITH ET AL) 3 August 1999 (1999-08-03) abstract; figures 1-3	1
X	WO 01/24989 A (TYCO ELECTRONICS CORP) 12 April 2001 (2001-04-12) figures	1
A	US 5 678 826 A (MILLER PATRICK LEE) 21 October 1997 (1997-10-21) cited in the application the whole document	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
12 November 2004	24/11/2004

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INTERNATIONAL SEARCH REPORT

[redacted]formation on patent family members

Inter[redacted]nal Application No
PCT/US2004/019304

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